File No. 101128 Committee Item No. 7
Board Item No. 15

COMMITTEE/BOARD OF SUPERVISORS

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Committee: Land Use and Economic Development **Date** October 18, 2010

Board of Supervisors Meeting **Date** 11/02/10

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* ☒	* ☒	2010 California Green Building Standards Code
☐	☐	
☐	☐	

Completed by: Alisa Somera **Date** October 14, 2010
Completed by: Alisa Somera **Date** October 21, 2010

An asterisked item represents the cover sheet to a document that exceeds 25 pages.
The complete document can be found in the file.

[San Francisco Building Code – Green Building Requirements – Repealing and Replacing]

Ordinance repealing Chapter 13C of the San Francisco Building Code in its entirety and enacting a new Chapter 13C that consists of the 2010 California Green Building Standards Code with local amendments; adopting findings of local conditions pursuant to California Health and Safety Code Section 17958.7 and Public Resources Code Section 25402.1(h)(2), and directing the Clerk of the Board to forward San Francisco's amendments and findings to the State Building Standards Commission; making environmental findings; and providing for an operative date of January 1, 2011.

Note: Additions are *single-underline italics Times New Roman*; deletions are ~~*strikethrough italics Times New Roman*~~. Board amendment additions are double underlined. Board amendment deletions are ~~strikethrough normal~~.

Be it ordained by the People of the City and County of San Francisco:

Section 1. Environmental Findings. The Planning Department has determined that the actions contemplated in this Ordinance are in compliance with the California Environmental Quality Act (California Public Resources Code sections 21000 et seq.). Said determination is on file with the Clerk of the Board of Supervisors in File No. 101128 and is incorporated herein by reference.

Section 2. General Findings.

A. The State of California adopts a new California Building Standards Code every three years that goes into effect throughout the State 180 days after publication. The California Building Standards Code is contained in Title 24 of the California Code of Regulations, and consists of several parts that are based upon model codes with amendments made by various State agencies with jurisdiction. This year the State has

adopted the California Green Building Standards Code, which goes into effect throughout the State on January 1, 2011.

B. Local jurisdictions are required to enforce the California Green Building Standards Code. Local jurisdictions may also enact more stringent standards than those contained in the California Green Building Standards Code where more stringent standards are reasonably necessary because of local conditions caused by climate, geology or topography.

C. San Francisco enacted Chapter 13C of the San Francisco Building Code in 2008, before the State of California had adopted green building requirements. In this Ordinance San Francisco repeals its existing Chapter 13C in its entirety and enacts a new Chapter 13C that consists of the 2010 California Green Building Standards Code together with local amendments thereto.

D. On August 18, 2010, at a duly noticed public hearing, the Building Inspection Commission considered this legislation.

Section 3. Findings regarding Local Conditions.

A. California Health & Safety Code Section 17958.7 provides that before making any changes or modifications to the California Green Building Standards Code and any other applicable provisions published by the State Building Standards Commission, the governing body must make an express finding that each such change or modification is reasonably necessary because of specified local conditions, and the findings must be filed with the State Building Standards Commission before the local changes or modifications can go into effect.

B. Public Resources Code Section 25402.1(h)(2),as well as Section 10-106 of the California Code of Regulations, Title 24, Part 1, Locally Adopted Energy Standards, authorizes the adoption and enforcement of more stringent local energy standards, provided that the local jurisdiction makes a determination that the local standards are more cost

effective and will save more energy than the current Statewide standards and the local jurisdiction files an application for approval with the California Energy Commission together with supporting documentation. A proposed ordinance may take effect only after the California Energy Commission has reviewed and formally approved the proposed local standards.

C. The City and County of San Francisco is unique among California communities with respect to local climatic, geological, topographical, and other conditions. A specific list of findings that support San Francisco's modifications to the 2010 California Green Building Standards Code and a section-by-section correlation of each modification with a specific numbered finding are contained in Exhibit A entitled "Standard Findings for San Francisco Amendments." In addition to the Standard Findings, the Board makes the following specific findings in support of San Francisco's local amendments to the California Green Building Standards Code:

(1) San Francisco is located at the tip of a peninsula and is served by the electricity grid at a single point, the Martin Substation. This single point of service makes San Francisco uniquely vulnerable to supply disruptions. Making San Francisco's building stock more energy efficient will reduce San Francisco's energy consumption and decrease its vulnerability to supply disruptions.

(2) As a coastal city surrounded on three sides by water, San Francisco is extremely vulnerable to climate change caused by global warming and the associated rise in sea levels. Construction of more energy efficient buildings can help San Francisco reduce its share of greenhouse gas emissions that are a significant contributor to global warming.

(3) San Francisco's 2004 Climate Action Plan identifies a number of specific serious impacts that global warming and the associated rise in sea levels would have on San Francisco's weather, water resources, physical landscape, ecosystem, human health, economy, and infrastructure.

(4) The City's Climate Action Plan found that energy use in buildings and facilities is responsible for approximately 50 percent of San Francisco's greenhouse gas emissions. The Plan further found that the potential for carbon dioxide reductions through electricity and gas savings in San Francisco's buildings is tremendous and that reducing electricity demand means that in-city power plants run less, creating fewer emissions.

D. Pursuant to California Health & Safety Code Section 17958.7, the Board of Supervisors finds and determines that the local conditions described in Exhibit A constitute a general summary of the most significant local conditions giving rise to the need for modification of the 2010 California Green Building Standards Code published by the State Building Standards Commission. The Board of Supervisors further finds and determines that the proposed modifications are reasonably necessary based on the local conditions set forth in Exhibit A and on the findings set forth in paragraph (C) above.

E. Based upon the findings of a study of the proposed revised Chapter 13C performed by Gabel Associates LLC, the Board of Supervisors hereby determines that the revised Chapter 13C standards are cost effective and will save more energy than the 2010 California Green Building Standards Code requirements.

Section 4. 2010 San Francisco Building Code. The San Francisco Building Code provides minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, maintenance and demolition of all buildings and structures, and quarrying, grading, excavation and filling of land in the City and County of San Francisco. Chapter 13C of the San Francisco Building Code establishes green building requirements. Chapter 13C is hereby repealed in its entirety and replaced with a new Chapter 13C that consists of the 2010 California Green Building Standards Code and the San Francisco amendments thereto. A copy of the 2010 California Green Building Standards Code as modified by San Francisco is

on file with the Clerk of the Board of Supervisors in File No. 101128 and is hereby declared to be part of this Ordinance as if set forth fully therein. Additions to the 2010 California Green Building Standards Code are shown in underlined type; deletions are shown with strikethrough.

Section 5. Continuance of Actions Under Prior Code. Nothing contained in this Ordinance shall be construed as abating any action now pending under or by virtue of any ordinance of the City and County of San Francisco hereby repealed, nor shall this Ordinance be construed as discontinuing, abating, modifying or altering any penalties accruing, or to accrue, or as waiving any right of the City under any ordinance in force at the time of passage of this Ordinance that establishes minimum green building requirements in the City and County of San Francisco.

Section 6. Severability. If any section, subsection, sentence, clause, or phrase of this Ordinance is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this Ordinance. The Board of Supervisors hereby declares that it would have passed this Ordinance, and each section, subsection, sentence, clause, or phrase of this Ordinance, irrespective of the fact that any one or more sections, subsections, sentences, clauses, or phrases be declared unconstitutional.

Section 7. Operative Date. This Ordinance shall take effect and be in full force on and after January 1, 2011 or the Ordinance's effective date, whichever is later. If, however, the California Energy Commission has not approved San Francisco's amendments to the California Green Building Standards Code by that time, this Ordinance shall not become effective until the Energy Commission has approved the local amendments.

Section 8. Upon final passage of this Ordinance, the Clerk of the Board of Supervisors is hereby directed to transmit this Ordinance, the San Francisco modifications to the 2010

California Green Building Standards Code, and Exhibit A to the State Building Standards Commission pursuant to the applicable provisions of State law.

APPROVED AS TO FORM:
DENNIS J. HERRERA, City Attorney

By: Judith A. Boyajian
JUDITH A. BOYAJIAN
Deputy City Attorney

FILE NO. 101128

LEGISLATIVE DIGEST

[San Francisco Building Code - Green Building Requirements – Repealing and Replacing]

Ordinance repealing Chapter 13C of the San Francisco Building Code in its entirety and enacting a new Chapter 13C that consists of the 2010 California Green Building Standards Code with local amendments; adopting findings of local conditions pursuant to California Health & Safety Code Section 17958.7 and Public Resources Code Section 25402.1(h)(2), and directing the Clerk of the Board to forward San Francisco's amendments and findings to the State Building Standards Commission; making environmental findings; and providing for an operative date of January 1, 2011.

Existing Law

The San Francisco Building Code regulates and controls the design, construction, quality of materials, use and occupancy, location, maintenance and demolition of all buildings and structures, and quarrying, grading, excavation and filling of land in the City and County of San Francisco. Chapter 13C establishes green building requirements.

Amendments to Current Law

On January 1, 2011, the 2010 California Green Building Standards Code will go into effect throughout the State of California. As in past State code adoption cycles, San Francisco will repeal its existing Building Code in its entirety and adopt a new San Francisco Building Code that consists of the new California Building Code and San Francisco's local amendments thereto. The new Chapter 13C integrates San Francisco's green building requirements into the 2010 California Green Building Standards Code. In the San Francisco amendments, additions to the 2010 California Green Building Standards Code are shown in underlined type; deletions are shown with strikethrough.

Background Information

Generally, the State of California adopts a new California Building Standards Code every three years that goes into effect throughout the State 180 days after publication. The California Building Standards Code is contained in Title 24 of the California Code of Regulations, and consists of several parts that are based upon model codes with amendments made by various State agencies with jurisdiction. The California Green Building Standards Code is a new code that has just been adopted by the State Building Standards Commission. It will go into effect throughout the State on January 1, 2011. San Francisco adopted Chapter 13C of the San Francisco Building Code in 2008, before the State enacted green building requirements.

Local jurisdictions are required to enforce the new California Green Building Standards Code. Local jurisdictions may also enact more stringent requirements than those contained in the

State Code where more stringent requirements are reasonably necessary because of local conditions caused by climate, geology, or topography. The local amendments are not effective until findings supporting any amendments, additions, or deletions to the State Code are adopted and sent to the State Building Standards Commission. Any green building requirements that San Francisco adopted when it enacted Chapter 13C will not apply to the 2010 California Green Building Standards Code unless and until those amendments are readopted and sent to the State Building Standards Commission.

In addition to filing San Francisco's local amendments with the State Building Standards Commission, the City must file an application and a supporting study with the California Energy Commission and obtain the approval of that Commission before the revised Chapter 13C can become effective. The specific findings that Public Resources Section 25402.1(h)(2) requires the Board to make in support of the application are included in the Ordinance.

SAN FRANCISCO
PLANNING DEPARTMENT

1650 Mission St.
Suite 400
San Francisco,
CA 94103-2479

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415.558.6378

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415.558.6409

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Information:
415.558.6377

Certificate of Determination
Exemption from Environmental Review

Case No.:	**2010.0689E**
Project Title:	**2010 San Francisco Building Codes Proposed Amendments**
Location:	Citywide
Project Sponsor:	Laurence Kornfield, Chief Building Inspector, Dept of Building Inspection
Staff Contact:	Brett Bollinger – (415) 575-9024 brett.bollinger@sfgov.org

PROJECT DESCRIPTION:

The proposed project includes the updates to the San Francisco Building, Electrical, Plumbing, and Mechanical Codes through the adoption of local amendments to the 2010 California Building Standard Codes. The California Building Code is Part 2, the California Residential Code is Part 2.5, the California Electrical Code is Part 3, the California Mechanical Code is Part 4, the California Plumbing Code is Part 5, and the California Green Building Code is Part 11 of 12 parts of the official compilation and publication of the adopted amendment and repeal of the building regulations to the California Code of Regulations, Title 24, also referred to as the California Building Standards Code. The California Building Code incorporates by adoption the 2009 International Building Code with necessary California amendments. The other codes are likewise based upon model codes amended by California. Local jurisdictions are required by State law to enforce the California Building Codes, and are allowed some discretion under the California Health and Safety Code with respect to local amendments.
(continued on next page)

EXEMPT STATUS:

General Rule Exclusion [State Guidelines, Section 15061(b)(3)].

DETERMINATION:

I do hereby certify that the above determination has been made pursuant to State and Local requirements.

Bill Wycko
Environmental Review Officer

August 16, 2010
Date

cc: Laurence Kornfield, DBI
Willy Yau, DBI
Sue Hestor
Virna Byrd, M.D.F.
Bulletin Board

BY AK

RECEIVED
BOARD OF SUPERVISORS
SAN FRANCISCO
2010 AUG 26 AM 11:21

PROJECT DESCRIPTION (continued):

The purpose of the 2010 San Francisco Building Code and other codes is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, access to persons with disabilities, sanitation, adequate lighting and ventilation and energy conservation; safety to life and property from fire and other hazards attributed to the built environment; to regulate and control the demolition of all buildings and structures, and the quarrying, grading, excavation, and filling of land; and to provide safety to fire fighters and emergency responders during emergency operations. (The full text of proposed amendments is available for review at the Department of Building Inspection (DBI)).

REMARKS:

As stated above, the City of San Francisco is required by State law to enforce the California Building, Electrical, Plumbing, Mechanical, Housing, and Fire Codes. The only discretionary activity left to local agencies related to local amendments. The local amendments proposed for adoption by the City of San Francisco primarily deals with procedural, informational and non-physical aspects of the various Codes. To the extent that the amendments relate to physical building conditions, they are intended to improve building safety and regulate building features such as wood decks, balconies, earthquake recording instruments, and sidewalks. The physical effects of such modifications are related to building design features which are very minor, localized in terms of visibility and impact, and intended to improve building safety.

CEQA Guidelines Section 15061(b)(3) provides an exemption from environmental review where it can be seen with certainty that the proposed project would not have a significant effect on the environment. Since the proposed code amendments would have no significant environmental effects, it is appropriately exempt from environmental review under the General Rule Exclusion (CEQA Guidelines Section 15061(b)(3)).

CEQA State Guidelines Section 15300.2 states that a categorical exemption shall not be used for an activity where there is a reasonable possibility that the activity will have a significant effect on the environment due to unusual circumstances. There are no unusual circumstances surrounding the current proposal that would suggest a reasonable possibility of a significant environmental effect. The proposed would have no significant environmental effects. The project would be exempt under the above-cited classification. For the above reasons, the proposed project is appropriately exempt from environmental review.

EXHIBIT A

STANDARD FINDINGS FOR SAN FRANCISCO BUILDING STANDARDS CODE AMENDMENTS:

1. Certain buildings/occupancies in San Francisco are at increased risk for earthquake-induced failure and consequent fire due to local hazardous microzones, slide areas, and local liquefaction hazards. (Geology)

2. Certain buildings/occupancies in San Francisco are at increased risk of fire due to high density of buildings on very small lots, with many buildings built up to the property lines. (Topography)

3. Topography of San Francisco has let to development of a high density of buildings on small lots, necessitating special provisions for exiting, fire separation, or fire-resistive construction. (Topography)

4. Many buildings are built on steep hills and narrow streets, requiring special safety consideration. (Topography)

5. Additional fire, structural and other protection is required due to high building density and crowded occupancy. (Topography)

6. San Francisco has narrow, crowded sidewalks due to building and population density and unusual topography. (Topography)

7. All rain water in San Francisco drains to the building drains and sewer; unusual geology, occasional extremely high local rainfall amounts, and the configuration of the City as a peninsula restrict the installation of separate storm water and sewer systems. (Topography, Climate, Geology)

8. Moist, corrosive atmosphere of salt-laden fog in San Francisco necessitates additional requirements. (Climate)

9. Not a building standard; no local findings required.

10. Soil conditions in this region induce adverse reactions with some materials, leading to premature failures and subsequent unsanitary conditions. (Climate)

11. The region is subject to fluctuating rainfall due to changes in climatic conditions. (Climate)

12. San Francisco is a peninsula surrounded on three sides by water at sea level;

mitigation of climate change impacts, including sea level rise, is critical to the long term protection of the local built environment and local infrastructure. (Topography)

13. Climate and potential climate change impacts San Francisco's water resources, including reservoirs and distribution facilities. (Climate)

14. Organic material in San Francisco's waste breaks down into methane gas which is a significant contributor to climate change. (Climate)

15. San Francisco is topographically constrained and its built environment occupies most available land, requiring minimization of debris and solid waste. (Topography)

16. Prevailing winds, coastal mountain ranges, and periodic seasonal high temperatures contribute to photochemical reactions that produce smog and ozone; limiting the emission of smog's chemical precursors - volatile organic chemicals and oxides of nitrogen - is necessary to health and safety. (Climate, Topography)

17. The aquifers underlying San Francisco are small relative to local population, necessitating ongoing water imports and special provisions to ensure efficient use of water in local buildings. (Geology)

BUILDING INSPECTION COMMISSION (BIC)

Department of Building Inspection Voice (415) 558-6164 - Fax (415) 558-6509
1660 Mission Street, San Francisco, California 94103-2414

August 27, 2010

Ms. Angela Calvillo, Clerk of the Board
Board of Supervisors
City Hall, 1 Dr. Carlton B. Goodlett Place, Room 244
San Francisco, CA 94102-4694

RE: Code amendments to the 2010 California Building, Mechanical, Electrical, Plumbing, Residential & Green Building Codes.

Dear Ms. Calvillo:

On August 18, 2010 the Building Inspection Commission held a public hearing on the proposed Code amendments referenced above.

The Commission voted unanimously (5-0) to recommend that the Board of Supervisors approve the amendments. The Commissioners voted as follows:

Vice-President Hechanova	Yes	Commissioner Mar	Yes
Commissioner Clinch	Yes	Commissioner Walker	Yes
Commissioner Lee	Yes	Commissioner Romero, excused	
President Murphy, excused			

Enclosed please find the Code Advisory Committee's recommendation to the BIC. Under separate cover, copies of the proposed amendments will follow from the Technical Services Division of the Department of Building Inspection. Should you have any questions, please do not hesitate to call me at 558-6164.

Sincerely,

Sonya Harris
Assistant Secretary

Cc: Mayor Gavin Newsom
Bill Barnes, BOS
Rick Caldeira, BOS
Deputy City Attorney John Malamut
Director Vivian Day
Gail Johnson, Office of Clerk of the Board
Starr Terrell, BOS
Alisa Somera, Board of Supervisors

City and County of San Francisco
Department of Building Inspection

Gavin Newsom, Mayor
Vivian L. Day, C.B.O., Director

August 12, 2010

Building Inspection Commission
1660 Mission Street
San Francisco, CA 94103

RE: Proposed 2010 amendments to the California Building Standards Code, CCR Title 24

Honorable Members of the Commission:

At the regular meeting of August 11, 2010, the full Code Advisory Committee (CAC) deliberated on and unanimously voted to approve, and transmit to the Building Inspection Commission, all of the 2010 San Francisco amendments to the 2010 California Title 24 building codes. This Committee has labored long and arduous hours over the past five months and feels that the work product before you represents the basis for a continuing safe and healthy building environment in San Francisco.

The San Francisco building codes approved by this Committee are:

1. 2010 San Francisco Building Code
   (which includes the amended California Building, Residential, and Green Building Standards Codes)
2. 2010 San Francisco Mechanical Code
3. 2010 San Francisco Electrical Code
4. 2010 San Francisco Plumbing Code

These documents are transmitted to you for your further action and a final approval to send them on to the Board of Supervisors. If you have any questions, please call me at (415) 575-6832.

Respectfully submitted,

Kirk Means
DBI Technical Services Division
Secretary to the Code Advisory Committee

cc: Vivian L. Day, C.B.O., Director
Laurence Kornfield, Deputy Director
Willy Yau, Manager, Technical Services Division
Ned Fennie, Jr., Chair, Code Advisory Committee
Bill Strawn, Communications Manager

2010
San Francisco Green Building Code

Amendments to the

2010 California Green Building Standards Code

Operative date: January 1, 2011

The City and County of San Francisco adopts the 2010 California Green Building Standards Code as amended by the City & County of San Francisco and herein printed as Chapter 13C of the San Francisco Building Code.

Codes and Standards
Title 24 Energy-Efficient Local Ordinances

Title:
Climate Zone 3
Energy Cost-Effectiveness Study

Prepared for:

Pat Eilert
Codes and Standards Program
Pacific Gas and Electric Company

Maril Pitcock
Government Partnership Program
Pacific Gas and Electric Company

Prepared by:
Gabel Associates, LLC

Last Modified: July 19, 2010

Climate Zone 3 Energy Cost-Effectiveness Study

July 19, 2010

Report prepared by:
Michael Gabel of Gabel Associates, LLC
1818 Harmon Street, Suite #1 Berkeley, CA 94703
(510) 428-0803 Email: mike@gabelenergy.com

Report on behalf of:
Pacific Gas and Electric Company's Codes and Standards Program,
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(530) 757-5261 Email: PLE2@pge.com

Pacific Gas and Electric Company's Government Partnership Program,
Maril Pitcock, 245 Market, San Francisco, Room 687, CA 94105
(415) 973-9944 Email: MxWL@pge.com

LEGAL NOTICE

This report was prepared by Pacific Gas and Electric Company and funded by the California utility customers under the auspices of the California Public Utilities Commission.

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Table of Contents

1.0 Executive Summary

This report presents the results of Gabel Associates' research and review of the feasibility and energy cost-effectiveness of building permit applicants exceeding the 2008 Building Energy Efficiency Standards to meet the minimum energy-efficiency requirements of local energy efficiency standards covering Climate Zone 3. A local government may use this report as a basis for demonstrating energy cost-effectiveness of a proposed green building or energy ordinance. The study assumes that such an ordinance requires, for the building categories covered, that building energy performance exceeds the 2008 TDV energy standard budget by at least 15%.

The study is also contained in the local government's application to the California Energy Commission (CEC) which must meet all requirements specified in Section 10-106 of the California Code of Regulations, Title 24, Part 1, Article 1: Locally Adopted Energy Standards. An ordinance shall be legally enforceable (a) after the CEC has reviewed and approved the local energy standards as meeting all requirements of Section 10-106; and (b) the ordinance has been adopted by the local government and filed with the Building Standards Commission.

The 2008 Building Energy Efficiency Standards, which took effect on January 1, 2010, are the baseline used to calculate the cost-effectiveness data.

2.0 Methodology and Assumptions

The energy performance impacts of exceeding the performance requirements of the 2008 Title 24 Building Energy Efficiency Standards (2008 Standards) have been evaluated in Climate Zone 3 using the following residential and nonresidential prototypical building types:

Small Single Family House 2-story 2,025 sf	**Large Single Family House** 2-story 4,500 sf
Low-rise Multi-family Apartments 8 dwelling units/2-story 8,442 sf	**High-rise Multi-family Apartments** 40 dwelling units/4-story 36,800 sf
Low-rise Office Building 1-story 10,580 sf	**High-rise Office Building** 5-story 52,900 sf

Methodology

The methodology used in the case studies is based on a design process for each of the proposed prototypical building types that first meets the minimum requirements and then exceeds the 2008 Standards by 15%. The process includes the following major stages:

Stage 1: Minimum Compliance with 2008 Standards:

Each prototype building design is tested for minimum compliance with the 2008 Standards, and the mix of energy measures are adjusted using common construction options so the building first just meets the Standards. The set of energy measures chosen represent a reasonable combination which reflects how designers, builders and developers are likely to achieve a specified level of performance using a relatively low first incremental (additional) cost.

Stage 2: Incremental Cost for Exceeding 2008 Standards by 15%:

Starting with that set of measures which is minimally compliant with the 2008 Standards, various energy measures are upgraded so that the building just exceeds the 2008 Standards by 15%. The design choices by the consultant authoring this study are based on many years of experience with architects, builders, mechanical engineers; and general knowledge of the relative acceptance and preferences of many measures, as well as their incremental costs. This approach tends to reflect how building energy performance is typically evaluated for code compliance and how it's used to select design energy efficiency measures. Note that lowest simple payback with respect to building site energy is not the primary focus of selecting measures; but rather the requisite reduction of Title 24 Time Dependent Valuation(TDV) energy at a reasonable incremental cost consistent with other non-monetary but important design considerations. A minimum and

maximum range of incremental costs of added energy efficiency measures is established by a variety of research means. A construction cost estimator, Building Advisory LLC, was contracted to conduct research to obtain current measure cost information for many energy measures; and Gabel Associates performed its own additional research to establish first cost data.

Stage 3: Cost Effectiveness Determination:

Energy savings in kWh and therms is calculated from the Title 24 simulation results to establish the annual energy cost savings and CO_2-equivalent reductions in greenhouse gases. A simple payback analysis in years is calculated by dividing the incremental cost for exceeding the 2008 Standards by the estimated annual energy cost savings.

Assumptions

Annual Energy Cost Savings

1. Annual site electricity (kWh) and natural gas (therms) saved are calculated using Micropas 8, state-approved energy compliance software for the 2008 Building Energy Efficiency Standards.

2. Average residential utility rates of $0.18/kWh for electricity and $1.15/therm for natural gas in current constant dollars; nonresidential rates are time-of-use rate schedules modeled explicitly in the DOE-2.1E computer simulation: PG&E A-6 schedule for electricity and PG&E G-NR1 schedule for natural gas.

3. No change (i.e., no inflation or deflation) of utility rates in constant dollars

4. No increase in summer temperatures from global climate change

Simple Payback Analysis

1. No external cost of global climate change -- and corresponding value of additional investment in energy efficiency and CO_2 reduction – is included

2. The cost of money (e.g., opportunity cost) invested in the incremental cost of energy efficiency measures is not included.

3.0 Minimum Compliance with 2008 Standards

The following energy design descriptions of the following building prototypes just meet the 2008 Standards in Climate Zone 3.

Small Single Family House

- 2,025 square feet
- 2-story
- 20.2% glazing/floor area ratio

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-30 Raised Floor over Garage/Open at 2nd Floor
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioner: None
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
50 Gallon Gas Water Heater: EF=0.62

Large Single Family House

- 4,500 square feet
- 2-story
- 22.0% glazing/floor area ratio

Energy Efficiency Measures
R-30 Roof w/ Radiant Barrier
R-13 Walls
R-19 Raised Floor
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(2) Furnaces: 80% AFUE
Air Conditioner: None
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(2) 50 Gallon Gas Water Heaters: EF=0.61

Low-rise Multi-family Apartments

- 8,442 square feet
- 8 units/2-story
- 12.5% glazing/floor area ratio

Energy Efficiency Measures
R-30 Roof w/ Radiant Barrier
R-13 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(8) Furnaces: 80% AFUE
Air Conditioner: None
R-6 Attic Ducts
(8) 40 Gallon Gas Water Heaters: EF=0.63
Pipe Insulation

High-rise Multifamily Apartments

- 36,800 sf,
- 40 units
- 4-story
- Window to Wall Ratio = 35.2%

Energy Efficiency Measures to Meet Title 24
R-19 under Metal Deck and additional R-11 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75
R-19 in Metal Frame Walls
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage
Dual Metal Windows: default U-factor=0.79, SHGC COG = 0.38
1.5 ton 4-pipe fan coils, 80% AFUE boiler, 70-ton scroll air cooled chiller @ 0.72 KW/ton
Central DHW boiler: 80% AFUE and recirculating system w/ timer-temperature controls

Low-rise Office Building

- Single Story
- 10,580 sf,
- Window to Wall Ratio = 37.1%

Energy Efficiency Measures to Meet Title 24
R-19 under Metal Deck, no cool roof
R-19 in Metal Frame Walls
R-0 (un-insulated) slab-on-grade 1st floor
Metal windows: Default glazing U=0.71, COG SHGC=0.54
Lighting = 0.858 w/sf: Open Office Areas: (60) 2-lamp T8 fixtures @58w each; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures; (40) 18w recessed CFLs, on/off lighting controls. Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers
R-6 duct insulation w/ ducts on roof
(1) Tank Gas Water Heaters EF=0.58

High-rise Office Building

- 5-story
- 52,900 sf,
- Window to Wall Ratio = 34.5%

Design "A" for Options 1 and 2

Energy Efficiency Measures to Meet Title 24
R-19 under Metal Deck, no cool roof
R-19 in Metal Frame Walls
R-0 (un-insulated) slab-on-grade 1st floor
Metal windows: Default glazing U=0.71, SHGC = 0.73
Lighting = 0.858 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 20% VAV boxes, electric water reheat on perimeter zones
R-6 duct insulation w/ ducts in conditioned
(1) Tank Gas Water Heaters EF=0.58

Design "B" for Options 3, 4 and 5

Energy Efficiency Measures to Meet Title 24
R-19 under Metal Deck, no cool roof
R-19 in Metal Frame Walls
R-0 (un-insulated) slab-on-grade 1st floor
Metal windows: Default glazing U=0.71, SHGC = .73
Lighting = 0.858 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 25% VAV boxes, hot water reheat on perimeter zones with 80% AFUE boiler.
R-6 duct insulation w/ ducts in conditioned
DHW 80% AFUE boiler

4.0 Incremental Cost to Exceed 2008 Standards by 15%

The following tables list the energy features and/or equipment included in the 2008 Standards base design, the efficient measure options, and an estimate of the incremental cost for each measure included **to improve the building performance to use 15% less TDV energy than the corresponding Title 24 base case design.**

Small Single Family House

- 2,025 square feet
- 2-story
- 20.2% glazing/floor area ratio

Incremental Cost Estimate to Exceed Title 24 by 15%
Single Family Prototype: 2,025 SF, Option 1 **2025 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-13): 2,550 sf @$0.31 to $0.54/sf	Upgrade	$ 791	$ 1,377	$ 1,084
R-30 Raised Floor over Garage/Open at 2nd Floor	-	$ -	$ -	$ -
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Furnace: 92% AFUE (from 80% AFUE)	Upgrade	$ 500	$ 1,200	$ 850
Air Conditioner: None	-	$ -	$ -	$ -
R-6 Attic Ducts (from R-8)	Downgrade	$ (325)	$ (225)	$ (275)
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
50 Gallon Gas Water Heater: EF=0.62	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 966**	**$ 2,352**	**$ 1,659**
Total Incremental Cost per Square Foot:		**$ 0.48**	**$ 1.16**	**$ 0.82**

Incremental Cost Estimate to Exceed Title 24 by 15%
Single Family Prototype: 2,025 SF, Option 2 **2025 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-13): 2,550 sf @$0.31 to $0.54/sf	Upgrade	$ 791	$ 1,377	$ 1,084
R-30 Raised Floor over Garage/Open at 2nd Floor	-	$ -	$ -	$ -
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Furnace: 80% AFUE	-	$ -	$ -	$ -
Air Conditioner: None	-	$ -	$ -	$ -
R-4.2 Attic Ducts (from R-8)	Downgrade	$ (650)	$ (450)	$ (550)
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
Instantaneous Gas Water Heater: RE=0.80 (from 50 Gal Gas: EF=0.62)	Upgrade	$ 900	$ 1,500	$ 1,200
Total Incremental Cost of Energy Efficiency Measures:		**$ 1,041**	**$ 2,427**	**$ 1,734**
Total Incremental Cost per Square Foot:		**$ 0.51**	**$ 1.20**	**$ 0.86**

Incremental Cost Estimate to Exceed Title 24 by 15%
Single Family Prototype: 2,025 SF, Option 3 **2025 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-21 Walls (from R-13): 2,550 sf @ $0.45 to $0.70/sf	Upgrade	$ 1,148	$ 1,785	$ 1,466
R-30 Raised Floor over Garage/Open at 2nd Floor	-	$ -	$ -	$ -
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Furnace: 90% AFUE (from 80% AFUE)	Upgrade	$ 500	$ 1,000	$ 750
Air Conditioner: None	-	$ -	$ -	$ -
R-4.2 Attic Ducts (from R-8)	Downgrade	$ (650)	$ (450)	$ (550)
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
50 Gallon Gas Water Heater: EF=0.61 (from EF=0.62)	Downgrade	$ (100)	$ (50)	$ (75)
Total Incremental Cost of Energy Efficiency Measures:		**$ 898**	**$ 2,285**	**$ 1,591**
Total Incremental Cost per Square Foot:		**$ 0.44**	**$ 1.13**	**$ 0.79**

Large Single Family House

- ☐ 4,500 square feet
- ☐ 2-story
- ☐ 22.0% glazing/floor area ratio

Incremental Cost Estimate to Exceed Title 24 by 15%
Single Family Prototype: 4,500 SF, Option 1 **4500 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/ Radiant Barrier): 2,700 sf @ 0.15 to 0.20/sf	Upgrade	$ 405	$ 540	$ 473
R-21 Walls (from R-13): 2,518 sf @ $0.45 to $0.70/sf	Upgrade	$ 1,133	$ 1,763	$ 1,448
R-30 Raised Floor (from R-19): 2,700 sf @ $0.25 to $0.35	Upgrade	$ 675	$ 945	$ 810
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(2) Furnaces: 80% AFUE	-	$ -	$ -	$ -
Air Conditioner: None	-	$ -	$ -	$ -
R-8 Attic Ducts (from R-6)	Upgrade	$ 450	$ 650	$ 550
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62 (from EF=0.61)	Upgrade	$ 100	$ 200	$ 150
Total Incremental Cost of Energy Efficiency Measures:		**$ 2,763**	**$ 4,098**	**$ 3,430**
Total Incremental Cost per Square Foot:		**$ 0.61**	**$ 0.91**	**$ 0.76**

Incremental Cost Estimate to Exceed Title 24 by 15%
Single Family Prototype: 4,500 SF, Option 2 **4500 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/ Radiant Barrier): 2,700 sf @ 0.15 to 0.20/sf	Upgrade	$ 405	$ 540	$ 473
R-15 Walls (from R-13): 2,518 sf @ $0.14 to $0.18/sf	Upgrade	$ 353	$ 453	$ 403
R-30 Raised Floor (from R-19): 2,700 sf @ $0.25 to $0.35	Upgrade	$ 675	$ 945	$ 810
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(2) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	$ 1,000	$ 2,400	$ 1,700
Air Conditioner: None	-	$ -	$ -	$ -
R-8 Attic Ducts (from R-6)	Upgrade	$ 450	$ 650	$ 550
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
(2) 50 Gallon Gas Water Heaters: EF=0.63 (from EF=0.61)	Upgrade	$ 100	$ 300	$ 200
Total Incremental Cost of Energy Efficiency Measures:		**$ 2,983**	**$ 5,288**	**$ 4,135**
Total Incremental Cost per Square Foot:		**$ 0.66**	**$ 1.18**	**$ 0.92**

Incremental Cost Estimate to Exceed Title 24 by 15%
Single Family Prototype: 4,500 SF, Option 3 **4500 sf** **Climate Zone 3**

Energy Efficiency Measures	Change	Incremental Cost Estimate		
R-38 Roof w/ Radiant Barrier (from R-30 w/ Radiant Barrier): 2,700 sf @ 0.15 to 0.20/sf	Upgrade	$ 405	$ 540	$ 473
R-19 Walls (from R-13): 2,518 sf @ $0.31 to $0.54/sf	Upgrade	$ 781	$ 1,360	$ 1,070
R-19 Raised Floor	-	$ -	$ -	$ -
Quality Insulation Installation (HERS)	Upgrade	$ 900	$ 1,200	$ 1,050
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(2) Furnaces: 80% AFUE	-	$ -	$ -	$ -
Air Conditioner: None	-	$ -	$ -	$ -
R-6 Attic Ducts	-	$ -	$ -	$ -
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
(2) 50 Gallon Gas Water Heaters: EF=0.63 (from EF=0.61)	Upgrade	$ 100	$ 300	$ 200
Total Incremental Cost of Energy Efficiency Measures:		**$ 2,186**	**$ 3,400**	**$ 2,793**
Total Incremental Cost per Square Foot:		**$ 0.49**	**$ 0.76**	**$ 0.62**

Low-rise Multi-family Apartments

- 8,442 square feet
- 8 units/2-story
- 12.5% glazing/floor area ratio

Incremental Cost Estimate to Exceed Title 24 by 15%
Multi-Family Prototype: 8,442 SF, Option 1 **8442 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-21 Walls (from R-13): 10,146 sf @ $0.45 to $0.70/sf	Upgrade	$ 4,566	$ 7,102	$ 5,834
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(8) Furnaces: 80% AFUE	-	$ -	$ -	$ -
Air Conditioner: None	-	$ -	$ -	$ -
R-4.2 Attic Ducts (from R-6)	Downgrade	$ (1,600)	$ (1,000)	$ (1,300)
Reduced Duct Leakage/Testing (HERS)	Upgrade	$ 2,400	$ 4,800	$ 3,600
(8) 40 Gallon Gas Water Heaters: EF=0.63	-	$ -	$ -	$ -
Remove Pipe Insulation	Downgrade	$ (1,600)	$ (1,200)	$ (1,400)
Total Incremental Cost of Energy Efficiency Measures:		**$ 3,766**	**$ 9,702**	**$ 6,734**
Total Incremental Cost per Square Foot:		**$ 0.45**	**$ 1.15**	**$ 0.80**

Incremental Cost Estimate to Exceed Title 24 by 15%
Multi-Family Prototype: 8,442 SF, Option 2 **8442 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 4,221 sf @ 0.15 to 0.20/sf	Upgrade	$ 633	$ 844	$ 739
R-19 Walls (from R-13): 10,146 sf @ $0.31 to $0.54/sf	Upgrade	$ 3,145	$ 5,479	$ 4,312
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(8) Furnaces: 80% AFUE	-	$ -	$ -	$ -
Air Conditioner: None	-	$ -	$ -	$ -
R-6 Attic Ducts	-	$ -	$ -	$ -
Reduced Duct Leakage/Testing (HERS)	Upgrade	$ 2,400	$ 4,800	$ 3,600
(8) 40 Gallon Gas Water Heaters: EF=0.63	-	$ -	$ -	$ -
Remove Pipe Insulation	Downgrade	$ (1,600)	$ (1,200)	$ (1,400)
Total Incremental Cost of Energy Efficiency Measures:		**$ 4,578**	**$ 9,923**	**$ 7,251**
Total Incremental Cost per Square Foot:		**$ 0.54**	**$ 1.18**	**$ 0.86**

Incremental Cost Estimate to Exceed Title 24 by 15%
Multi-Family Prototype: 8,442 SF, Option 3 **8442 sf** **Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 4,221 sf @ 0.25 to 0.35/sf	Downgrade	$ (1,477)	$ (1,055)	$ (1,266)
R-19 Walls (from R-13): 10,146 sf @ $0.31 to $0.54/sf	Upgrade	$ 3,145	$ 5,479	$ 4,312
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(8) Furnaces: 90% AFUE (from 80% AFUE)	Upgrade	$ 4,000	$ 8,000	$ 6,000
Air Conditioner: None	-	$ -	$ -	$ -
R-4.2 Attic Ducts (from R-6)	Downgrade	$ (1,600)	$ (1,000)	$ (1,300)
Reduced Duct Leakage/Testing (HERS)	Upgrade	$ 2,400	$ 4,800	$ 3,600
(8) 40 Gallon Gas Water Heaters: EF=0.62 (from EF=0.63)	Downgrade	$ (400)	$ -	$ (200)
Remove Pipe Insulation	Downgrade	$ (1,600)	$ (1,200)	$ (1,400)
Total Incremental Cost of Energy Efficiency Measures:		**$ 4,468**	**$ 15,024**	**$ 9,746**
Total Incremental Cost per Square Foot:		**$ 0.53**	**$ 1.78**	**$ 1.15**

High-rise Multifamily Apartments

- 36,800 sf,
- 40 units/4-story
- Window to Wall Ratio = 31.6%

Incremental Cost Estimate to Exceed Title 24 by 15%
High-rise Residential Prototype: 36,800 SF, Option 1 **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck **and additional R-30 batt below** (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75; 9,200 sf @ $0.30 to $0.40/sf	Upgrade	$ 2,760	$ 3,680	$ 3,220
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage	-	$ -	$ -	$ -
Dual Metal Windows: **COG U-factor=0.3, COG SHGC=0.27** 6,240 sf @ $2.00 to $3.00/sf	Upgrade	$ 12,480	$ 18,720	$ 15,600
1.5 ton 4-pipe fan coil, **98% AFUE** boiler, 60-ton scroll air cooled chiller 0.72 KW/ton (cost of boiler below under DHW)	Upgrade	$ -	$ -	$ -
Central DHW boiler: **98% AFUE** and recirculating system w/ timer-temperature controls	Upgrade	$ 4,000	$ 8,000	$ 6,000
Total Ificremental Cost of Energy Efficiency Measures:		**$ 19,240**	**$ 30,400**	**$ 24,820**
Total Incremental Cost per Square Foot:		**$ 0.52**	**$ 0.83**	**$ 0.67**

Incremental Cost Estimate to Exceed Title 24 by 15%
High-rise Residential Prototype: 36,800 SF, Option 2 — **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck and additional R-11 batt below (no framing); with no cool roof; 9,200 sf @ $0.35 to $0.50/sf	Downgrade	$ (3,220)	$ (4,600)	$ (3,910)
R-19 in Metal Frame Walls **w/ 1" continuous outside (R-5);** 12,112 sf @ $4.00/sf to $7.00/sf	Upgrade	$ 48,448	$ 84,784	$ 66,616
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage	-	$ -	$ -	$ -
Dual Metal Windows: **COG U-factor=0.3, COG SHGC=0.31** 6,240 sf @ $1.00 to $2.00/sf	Upgrade	$ 6,240	$ 12,480	$ 9,360
1.5 ton 4-pipe fan coil, **98% AFUE** boiler, 60-ton scroll air cooled chiller 0.72 KW/ton (cost of boiler below under DHW)	Upgrade	$ -	$ -	$ -
Central DHW boiler: **98% AFUE** and recirculating system w/ timer-temperature controls	Upgrade	$ 4,000	$ 8,000	$ 6,000
Total Incremental Cost of Energy Efficiency Measures:		**$ 55,468**	**$100,664**	**$ 78,066**
Total Incremental Cost per Square Foot:		**$ 1.51**	**$ 2.74**	**$ 2.12**

Incremental Cost Estimate to Exceed Title 24 by 15%
High-rise Residential Prototype: 36,800 SF, Option 3 — **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck **and additional R-30 batt below** (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75; 9,200 sf @ $0.30 to $0.40/sf	Upgrade	$ 2,760	$ 3,680	$ 3,220
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage	-	$ -	$ -	$ -
Dual Metal Windows: **COG U-factor=0.3,** COG SHGC=0.38 6,240 sf @ $0.50 to $1.00/sf	Upgrade	$ 3,120	$ 6,240	$ 4,680
1.5 ton 4-pipe fan coil, **94% AFUE boiler**, 70-ton scroll air cooled chiller 0.72 KW/ton	Upgrade	$ 3,000	$ 6,000	$ 4,500
Central DHW boiler: **94% AFUE** and recirculating system w/ timer-temperature controls **and solar water heating, 25% Net Solar Fraction** (cost of boiler above under space heating boiler)	Upgrade	$ 40,000	$ 55,000	$ 47,500
Total Incremental Cost of Energy Efficiency Measures:		**$ 48,880**	**$ 70,920**	**$ 59,900**
Total Incremental Cost per Square Foot:		**$ 1.33**	**$ 1.93**	**$ 1.63**

Low-rise Office Building

- Single Story
- 10,580 sf,
- Window to Wall Ratio = 37.1%

Incremental Cost Estimate to Exceed Title 24 by 15%
Nonresidential Prototype: 10,580 SF, Option 1 **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate Min	Max	Avg
R-19 under Metal Deck **and additional R-13 batt below (no framing)**; **with Cool Roof Reflectance = 0.55, Emittance = 0.75;** 10,580 sf @ $0.60 to $0.85/sf	Upgrade	$ 6,348	$ 8,993	$ 7,671
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.38;** 3,200 sf @ $1.50 to $2.00/sf	Upgrade	$ 4,800	$ 6,400	$ 5,600
Lighting = 0.783 w/sf: Open Office Areas: (60) 2-lamp T8 fixtures @58w each; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures, (40) 18w recessed CFLs: **(28) multi-level ocupancy sensors on T8s and recessed CFLa @ $75 to $100 each.** Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.	Upgrade	$ 2,100	$ 2,800	$ 2,450
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers	-	$ -	$ -	$ -
R-6 duct insulation w/ducts on roof, **HERS verified duct leakage**	Upgrade	$ 1,000	$ 1,800	$ 1,400
(1) Tank Gas Water Heaters EF=0.58	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 14,248**	**$ 19,993**	**$ 17,121**
Total Incremental Cost per Square Foot:		**$ 1.35**	**$ 1.89**	**$ 1.62**

Incremental Cost Estimate to Exceed Title 24 by 15%
Nonresidential Prototype: 10,580 SF, Option 2 **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck **and additional R-25 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75;** 10,580 sf @ $0.75 to $1.10/sf	Upgrade	$ 7,935	$ 11,638	$ 9,787
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.27;** 3,200 sf @ $2.00 to $3.00/sf	Upgrade	$ 6,400	$ 9,600	$ 8,000
Lighting = 0.858 w/sf: Open Office Areas: (60) 2-lamp T8 fixtures @58w each; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures; (40) 18w recessed CFLs, on/off lighting controls. Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.	-	$ -	$ -	$ -
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers, **Controls to include "Cycle on at night"**	Upgrade	$ 300	$ 600	$ 450
R-6 duct insulation w/ducts on roof, **HERS verified duct leakage**	Upgrade	$ 1,000	$ 1,800	$ 1,400
(1) Tank Gas Water Heaters EF=0.58	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 15,635**	**$ 23,638**	**$ 19,637**
Total Incremental Cost per Square Foot:		**$ 1.48**	**$ 2.23**	**$ 1.86**

Incremental Cost Estimate to Exceed Title 24 by 15%

Nonresidential Prototype: 10,580 SF, Option 3 — **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck **and additional R-13 batt below (no framing)**; no cool roof; 10,580 sf @ $0.25 to $0.35/sf	Upgrade	$ 2,645	$ 3,703	$ 3,174
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.38;** 3,200 sf @ $1.50 to $2.00/sf	Upgrade	$ 4,800	$ 6,400	$ 5,600
Lighting = 0.746 w/sf: Open Office Areas: **(32) HO 2-lamp T8 fixtures @74w each**; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures, (40) 18w recessed CFLs: **(28) multi-level ocupancy sensors on T8s and recessed CFLa @ $75 to $100 each**. Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls	Upgrade	$ 820	$ 1,648	$ 1,234
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers, **Controls to include "Cycle on at night"**	Upgrade	$ 300	$ 600	$ 450
R-6 duct insulation w/ ducts on roof	-			
(1) Tank Gas Water Heaters EF=0.58	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 8,565**	**$ 12,351**	**$ 10,458**
Total Incremental Cost per Square Foot:		**$ 0.81**	**$ 1.17**	**$ 0.99**

High-rise Office Building

- 5-story
- 52,900 sf,
- Window to Wall Ratio = 34.5%

Incremental Cost Estimate to Exceed Title 24 by 15%

Nonresidential Prototype: 52,900 SF, Option 1 — **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate Min	Max	Avg
R-19 under Metal Deck with **Cool Roof Reflectance = 0.55, Emittance = 0.75;** 10,580 sf @ $0.35 to $0.50/sf	Upgrade	$ 3,703	$ 5,290	$ 4,497
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.38;** 16,000 sf @ $2.00 to $2.50/sf	Upgrade	$ 32,000	$ 40,000	$ 36,000
Lighting = 0.858 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	-	$ -	$ -	$ -
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; **15% VAV boxes,** electric water reheat on perimeter zones	Upgrade	$ 26,450	$ 39,675	$ 33,063
R-6 duct insulation w/ ducts in conditioned	-	$ -	$ -	$ -
(1) Tank Gas Water Heaters EF=0.58	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 62,153**	**$ 84,965**	**$ 73,559**
Total Incremental Cost per Square Foot:		**$ 1.17**	**$ 1.61**	**$ 1.39**

Incremental Cost Estimate to Exceed Title 24 by 15%
Nonresidential Prototype: 52,900 SF, Option 2 Climate Zone 3

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck **and additional R-13 batt below (no framing)**; no cool roof; 10,580 sf @ $0.25 to $0.35/sf	Upgrade	$ 2,645	$ 3,703	$ 3,174
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.54**; 16,000 sf @ $1.50 to $2.00/sf	Upgrade	$ 24,000	$ 32,000	$ 28,000
Lighting = 0.783 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs **multi-level ocupancy sensors on T8s and recessed CFLs @ $75 to $100 each.** Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	Upgrade	$ 10,500	$ 14,000	$ 12,250
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; **15% VAV boxes,** electric water reheat on perimeter zones	Upgrade	$ 26,450	$ 52,900	$ 39,675
R-6 duct insulation w/ ducts in conditioned	-	$ -	$ -	$ -
(1) Tank Gas Water Heaters EF=0.58	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 63,595**	**$102,603**	**$ 83,099**
Total Incremental Cost per Square Foot:		**$ 1.20**	**$ 1.94**	**$ 1.57**

Incremental Cost Estimate to Exceed Title 24 by 15%

Nonresidential Prototype: 52,900 SF, Option 3 **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck **and additional R-13 batt below (no framing)**; no cool roof; 10,580 sf @ $0.25 to $0.35/sf	Upgrade	$ 2,645	$ 3,703	$ 3,174
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.54**; 16,000 sf @ $1.50 to $2.00/sf	Upgrade	$ 24,000	$ 32,000	$ 28,000
Lighting = 0.858 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	-	$ -	$ -	$ -
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; **20% VAV boxes,** hot water reheat on perimeter zones with **92% AFUE boiler** (cost of boiler included below for DHW)	Upgrade	$ 26,450	$ 52,900	$ 39,675
R-6 duct insulation w/ ducts in conditioned	-	$ -	$ -	$ -
DHW **92% AFUE boiler**	Upgrade	$ 2,000	$ 4,000	$ 3,000
Total Incremental Cost of Energy Efficiency Measures:		**$ 55,095**	**$ 92,603**	**$ 73,849**
Total Incremental Cost per Square Foot:		**$ 1.04**	**$ 1.75**	**$ 1.40**

Incremental Cost Estimate to Exceed Title 24 by 15%

Nonresidential Prototype: 52,900 SF, Option 4 — **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate Min	Max	Avg
R-19 under Metal Deck **and additional R-13 batt below (no framing)**; **with Cool Roof Reflectance = 0.55, Emittance = 0.75;** 10,580 sf @ $0.60 to $0.85/sf	Upgrade	$ 6,348	$ 8,993	$ 7,671
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.54**; 16,000 sf @ $1.50 to $2.00/sf	Upgrade	$ 24,000	$ 32,000	$ 28,000
Lighting = 0.783 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs **multi-level ocupancy sensors on T8s and recessed CFLs @ $75 to $100 each.** Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	Upgrade	$ 10,500	$ 14,000	$ 12,250
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 25% VAV boxes, hot water reheat on perimeter zones with **92% AFUE boiler** (cost of boiler included below for DHW).	Upgrade	$ -	$ -	$ -
R-6 duct insulation w/ ducts in conditioned	-	$ -	$ -	$ -
DHW **92% AFUE boiler**	Upgrade	$ 2,000	$ 4,000	$ 3,000
Total Incremental Cost of Energy Efficiency Measures:		**$ 42,848**	**$ 58,993**	**$ 50,921**
Total Incremental Cost per Square Foot:		**$ 0.81**	**$ 1.12**	**$ 0.96**

Incremental Cost Estimate to Exceed Title 24 by 15%
Nonresidential Prototype: 52,900 SF, Option 5 **Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate Min	Max	Avg
R-19 under Metal Deck **and additional R-13 batt below (no framing)**; **with Cool Roof Reflectance = 0.55, Emittance = 0.75;** 10,580 sf @ $0.60 to $0.85/sf	Upgrade	$ 6,348	$ 8,993	$ 7,671
R-19 in Metal Frame Walls	-	$ -	$ -	$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	$ -	$ -	$ -
Metal windows: default U=0.71, **COG SHGC=0.54**; 16,000 sf @ $1.50 to $2.00/sf	Upgrade	$ 24,000	$ 32,000	$ 28,000
Lighting = 0.678 w/sf: Open Office Areas: **(160) 2-lamp T8 fixtures @74w each;** no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs **multi-level ocupancy sensors on T8s and recessed CFLs @ $75 to $100 each.** Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	Upgrade	$ 10,500	$ 14,000	$ 12,250
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 25% VAV boxes, hot water reheat on perimeter zones with **94% AFUE boiler** (cost of boiler included below for DHW).	Upgrade	$ -	$ -	$ -
R-6 duct insulation w/ ducts in conditioned	-	$ -	$ -	$ -
DHW **94% AFUE boiler**	Upgrade	$ 4,000	$ 8,000	$ 6,000
Total Incremental Cost of Energy Efficiency Measures:		**$ 44,848**	**$ 62,993**	**$ 53,921**
Total Incremental Cost per Square Foot:		**$ 0.85**	**$ 1.19**	**$ 1.02**

5.0 Cost -Effectiveness Determination

Regardless of the building design, occupancy profile and number of stories, the incremental improvement in overall annual energy performance of buildings in exceeding the 2008 Standards is determined to be cost-effective. However, each building's overall design, occupancy type and specific design choices may allow for a large range of incremental costs for exceeding 2008 Standards, estimated annual energy cost savings, and subsequent payback period.

Small Single Family

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (Years)
2,025 sf (Option 1)	78	85	$1,659	$112	14.8
2,025 sf (Option 2)	72	87	$1,734	$113	15.3
2,025 sf (Option 3)	85	81	$1,592	$108	14.7
Averages:	78	84	$1,662	$111	15.0

Annual Reduction in CO2-equivalent: 0.50 lb./sq.ft.-year, 1,017 lb./building-year
Increased Cost / lb. CO2-e reduction: $1.63

Large Single Family

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (Years)
4,500 sf (Option 1)	181	105	$3,431	$153	22.4
4,500 sf (Option 2)	88	117	$4,136	$150	27.5
4,500 sf (Option 3)	172	106	$2,793	$153	18.3
Averages:	147	109	$3,453	$152	22.7

Annual Reduction in CO2-equivalent: 0.30 lb./sq.ft.-year, 1,339 lb./building-year
Increased Cost / lb. CO2-e reduction: $2.58

Low-rise Multi-family Apartments

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (Years)
8-Unit, 8,442 sf (Option 1)	569	345	$6,734	$499	13.5
8-Unit, 8,442 sf (Option 2)	552	342	$7,251	$493	14.7
8-Unit, 8,442 sf (Option 3)	453	337	$9,746	$469	20.8
8-Unit, 8,442 sf (Option 4)	57	396	$8,323	$466	17.9
Averages:	354	358	$8,440	$476	17.8

Annual Reduction in CO2-equivalent: 0.51 lb./sq.ft.-year, 4,316 lb./building-year
Increased Cost / lb. CO2-e reduction: $1.86

High-rise Multi-family Apartments

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (Years)
36,800 sf (Option 1)	668	1766	$24,820	$2,151	11.5
36,800 sf (Option 2)	-2616	2314	$78,066	$2,190	35.6
36,800 sf (Option 3)	-2519	2811	$51,940	$2,779	18.7
Averages:	-1489	2297	$51,609	$2,374	22.0

Annual Reduction in CO2-equivalent: 0.71 lb./sq.ft.-year, 26,067 lb./building-year
Increased Cost / lb. CO2-e reduction: $1.97

Low-rise Office Building

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (Years)
10,580 sf (Option 1)	10410	-79	$17,121	$2,765	6.2
10,580 sf (Option 2)	8612	-182	$19,637	$2,247	8.7
10,580 sf (Option 3)	10594	-223	$10,458	$2,475	4.2
Averages:	9872	-161	$15,738	$2,496	6.4

Annual Reduction in CO2-equivalent: 0.24 lb./sq.ft.-year, 2,564 lb./building-year
Increased Cost / lb. CO2-e reduction: $7.17

High-rise Office Building

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost ($)	Annual Energy Cost Savings ($)	Simple Payback (Years)
52,900 sf (Option 1)	76452	-16	$73,559	$17,629	4.2
52,900 sf (Option 2)	74762	-3	$83,099	$16,457	5.0
52,900 sf (Option 3)	40583	4523	$73,849	$16,248	4.5
52,900 sf (Option 4)	55173	2217	$50,921	$34,725	1.5
52,900 sf (Option 5)	40996	4871	$53,921	$31,964	1.7
Averages:	57593	2318	$67,070	$23,405	3.4

Annual Reduction in CO2-equivalent: 1.34 lb./sq.ft.-year, 70,667 lb./building-year
Increased Cost / lb. CO2-e reduction: $0.95

Conclusions

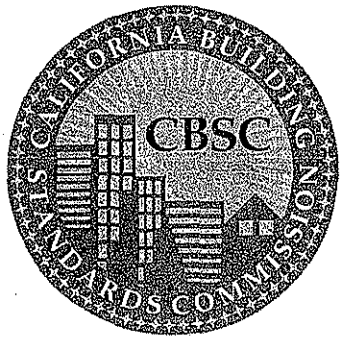
Regardless of the building design, occupancy profile and number of stories, the incremental improvement in overall annual energy performance of buildings which exceed the 2008 Title 24 Building Energy Efficiency Standards by 15% appears cost-effective. However, each building's overall design, occupancy type and specific design choices may allow for a large range of incremental first cost and payback. As with simply meeting the requirements of the Title 24 energy standards, a permit applicant complying with the energy requirements of a green building ordinance should carefully analyze building energy performance to reduce incremental first cost and the payback for the required additional energy efficiency measures.

CALIFORNIA 2010 GREEN BUILDING STANDARDS CODE

CALGreen

California Code of Regulations Title 24, Part 11

California Building Standards Commission



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